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School is in Session: Welcome to Boosters 101

By Megan Davidson

Have your pencils and notebooks handy because school is in session. Welcome to Boosters 101.

No, this lesson is not about a child seat or an amusement park ride if you looked up boosters in the encyclopedia. This is about rocket boosters -- and not only that, but the largest, most powerful ones ever built that will give the "lift" necessary to send astronauts to an asteroid and to Mars on NASA's new

*See **Boosters 101** on page 2*

Orbital ATK technicians remove a rounding fixture from the solid rocket motor center segment. The fixture is used to round the segment to prepare it for a solid handling install. The handling ring is the silver ring on the end of the segment. (Orbital ATK)

Marshall Star to Update to a Mobile-Friendly Format

By Jena Rowe

On Feb. 25, the Marshall Star will adapt a mobile-friendly format to keep Marshall Space Flight Center team members informed while on-the-go or when viewing the weekly publication from a smart phone or tablet computer. The new format will no longer include a PDF document.

Following NASA Headquarters' lead, the newly formatted Marshall Star will take advantage of reading and sharing capabilities when viewed on smartphone and tablet computers.

The new format will use mobile capabilities such as the "Reader View" available on various mobile devices. In this view, the Star can be viewed in plain text, eliminating any background distractions while keeping images, videos and links live for easy navigation.

Readers will be able to easily share

*See **Mobile-Friendly Star** on page 4*

Boosters 101 *Continued from page 1*

rocket, the Space Launch System.

Booster Basics

Twin solid rocket boosters were first introduced for human spaceflight missions on the first launch of the space shuttle April 12, 1981. They operate in parallel with the main engines for the first two minutes of flight to provide the thrust needed for the launch vehicle to escape the gravitational pull of Earth. While the shuttle booster used a four-segment solid rocket motor, SLS will use a five-segment motor for more power. The added booster segment contains more solid propellant to allow the rocket to lift more weight and reach a higher altitude before the boosters separate from the core stage.

"To get off the ground, a rocket -- especially one with the capabilities that SLS will have -- needs a ton of thrust," said Pat Lampton, technical assistant for solid propulsion at NASA's Marshall Space Flight Center, where the SLS Program is managed for the agency. "You can get that higher amount from a solid propellant."

The primary components of the SLS booster contain the motor, forward structures and aft structures. These components combine for a total weight of 1.6 million pounds.

Along with propellant, major components of a motor are:

- Case -- The rocket motor case is made of a high-strength metal that contains combustion pressure and transmits thrust forces to the rocket.
- Nozzle -- Controls expansion of chamber pressures and includes the thrust vector control system, which guides and controls the rocket. The nozzle is the most complex part of the booster and is big enough for an average adult to walk through.
- Igniter -- A little rocket motor that provides high pressure, high temperature gases to initiate the main propellant materials.
- Insulation -- Material that keeps the hardware from melting from extreme temperatures created by the combustion gases.

The forward structures include the nose cone, frustum and forward skirt. The nose cone and frustum protect the rocket from the impact of aerodynamic pressure and heating during ascent. The forward skirt houses booster avionics that work with the SLS avionics to monitor booster conditions and steer the exhaust nozzles. It bears most of the forces carried onto the rocket during flight, and serves as one of two attachment points for the SLS

An Orbital ATK technician installs one of more than 900 plies of insulation onto the inner diameter of an SLS booster segment case. The insulation serves to protect the case metal from the heat of propellant combustion during test fire or launch. Orbital ATK is the prime contractor for the SLS boosters. (Orbital ATK)

core stage. The core stage, towering more than 200 feet tall with a diameter of 27.6 feet, will store cryogenic liquid hydrogen and liquid oxygen that will feed the vehicle's RS-25 engines.

The aft structure is composed of the aft skirt and thrust vector control system. The aft skirt has to support the entire weight of the SLS vehicle on the launch vehicle on the launch pad and contains the thrust vector control system that steers the rocket nozzle based on commands from the booster avionics.

When completed, each SLS booster will be approximately 177 feet long -- taller than the Statue of Liberty from base to torch. They will be 12 feet in diameter, weigh 801 tons and produce 3.6 million pounds of thrust. SLS will use two, five-segment boosters. The motor is designed to burn for 126 seconds. During that time, it produces more than 75 percent of the total SLS thrust.

Continue reading this story -- including how a booster is made and tested -- and watch a video here.

Davidson, an ASRC Federal/Analytical Services employee, supports the Office of Strategic Analysis & Communications.

Former NASA Astronaut Leland Melvin to Speak at Marshall's Black History Month Event Feb. 23

NASA's Marshall Space Flight Center will host a Black History Month observance on Feb. 23. The keynote speaker will be former NASA astronaut Leland Melvin, veteran of space shuttle missions STS-122 and STS-129. The event is scheduled for 10-11 a.m. at Marshall's Activities Building 4316.

View Melvin's official bio here.

The theme is "A Century of Black Life, History, and Culture." Scheduled activities include performances by the First Missionary Baptist Church Daycare Center and the Voices of Marshall. Ethnic food sampling will be available. In observance of Black History Month, a profile video was created to highlight Tommy Thompson, a Marshall systems engineer. View the video here.

For more information about the event, please contact Abbie Johnson at 256-544-0014 or abbie.j.johnson@nasa.gov or Betty Humphery at 256-544-0034 or betty.b.humphery@nasa.gov.

Bill Emrich Honored As 2015 AIAA Engineer of the Year For NASA Nuclear Thermal Propulsion Research

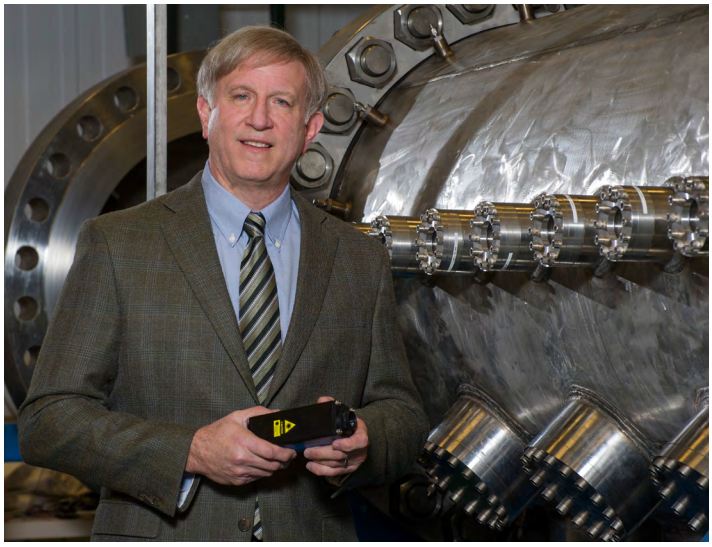
By Christopher Blair

The American Institute of Aeronautics and Astronautics recently honored Bill Emrich with its prestigious 2015 Engineer of the Year award for his innovative nuclear propulsion research and testing at NASA's Marshall Space Flight Center.

"It's unbelievable and an honor that I never expected to receive," said Emrich of the award. "This was definitely a surprise."

Emrich will receive the award at the AIAA Propulsion and Energy Forum and Exposition July 27-29 in Orlando, Florida. The award is presented to a member of AIAA who has made a recent individual contribution in the application of scientific and mathematical principles leading to a significant accomplishment or event. Emrich conceived, designed and now operates the megawatt-class Nuclear Thermal Rocket Element

*See **Engineer of the Year** on page 4*



Bill Emrich was named the 2015 Engineer of the Year by the American Institute of Aeronautics and Astronautics for his innovative nuclear propulsion research at the Marshall Center. (NASA/MSFC/Emmett Given)

Mobile-Friendly Star *Continued from page 1*

an entire issue or a particular story using email or social media. Each issue and each story will have its own hyperlink, making it easily shareable with friends, coworkers or customers. The new format will also have an RSS feed. Readers can simply follow the RSS feed and be notified when a new issue of the Marshall Star is published.

High-resolution images in the Star will not only be presented in a larger viewing area, but readers can easily download these images as well. By clicking on an image, it will open in a new window in its highest available resolution and can easily be saved to your smartphone, tablet or computer.

The changes reflected in the Feb. 25 Marshall Star may seem subtle at first but the benefits for the reader will be unmistakable.

Rowe, the Marshall Star editor and an ASRC Federal/ Analytical Services employee, supports the Office of Strategic Analysis & Communications.

Engineer of the Year *Continued from page 3*

Environment Simulator.

NTREES allows engineers and researchers to perform realistic, non-nuclear testing of prototypical nuclear rocket fuel elements by creating an environment that simultaneously reproduces the power, flow and temperature conditions that the fuel element would be expected to encounter during actual nuclear engine operation.

"These technologies have the potential to drastically reduce travel time to Mars and other destinations by providing high thrust at efficiencies at least twice that of today's best chemical engines." Emrich said. "This work is wonderfully rewarding because I've always dreamed of working on rocket engines that would send the first explorers to Mars and this project focuses all my engineering skills on achieving that goal."

As only the second Marshall team member to win the coveted AIAA award, Emrich quickly acknowledged all the support he received along the way. "I thank my boss, Jim Martin, along with Michael Schoenfeld, Robert Moran, Boise Pearson, Tommy Reid and all the other engineers and technicians who contributed detailed designs, allowing me to focus on the larger systems of NTREES," Emrich said. "Marshall's engineering management has been very supportive, working hard to get the resources needed for us to be successful."

"Bill's contributions to NTREES have taken this program to the next level," said Preston Jones, deputy director of engineering at Marshall. "We are proud of his accomplishments, and this award is a testament to his level of professionalism and expertise."

Emrich attributes part of his success to his commitment to lifelong learning. He earned numerous college degrees including a bachelor's degree in mechanical engineering from Georgia Institute of Technology; a master's degree in nuclear engineering from the Massachusetts Institute of Technology; and a doctorate in mechanical and aerospace engineering from the University of Alabama in Huntsville, where he now teaches nuclear rocket propulsion for the Mechanical and Aerospace Engineering Department and mentors young engineers.

Blair, ASRC Federal/Analytical Services employees, supports the Office of Strategic Analysis & Communications.

A Composite Booster Gets a Burst of Energy

By David Hitt

Turning a rocket booster case into spaghetti sounds more like magic than engineering, but a test that did just that could be an important step in the future of human space exploration.

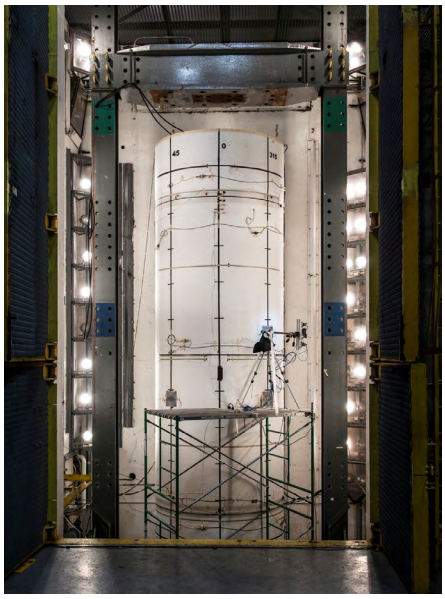
As NASA prepares to test the massive solid rocket booster for the agency's Space Launch System rocket in March, a team of engineers is looking even farther into the future by exploring an advanced composite that someday might be used to create even more powerful boosters. To understand how well these materials could withstand the immense strains of a launch, the engineers conducted a test that involved pressurizing a booster structure made of composite materials to its breaking point to see how it compares with the metallic booster cases currently used.

In the case burst test, a booster case 25 feet long and 92 inches in diameter was subjected to 3,000 pounds per square inch of pressure -- well beyond what would be encountered in flight conditions -- to verify exactly what loads the composite material could withstand.

"The test is very dramatic," said Angie Jackman, of the SLS Spacecraft/Payload Integration and Evolution Office at NASA's Marshall Space Flight Center, where the SLS Program is managed for the agency. "When composites fail, it's the glue or the resin that fails first -- not the fiber that fails. There's a big boom, and it's all spaghetti."

Before the test, damage was purposefully caused at multiple points on the case to study what effect it would have on how the case fared. Even so, the damaged case performed as well as an intact case, demonstrating not only the composite case could withstand the rigors of launch, but that it could do so even in a damaged condition.

The successful test demonstrated that a composite case can withstand damage and still handle the stresses of space launch. (Orbital ATK)



Standing more than two stories tall and almost 8 feet in diameter, the composite test structure was pressurized with water until it burst. (Orbital ATK)

The test was conducted by Orbital ATK of Promontory, Utah, which made the solid rocket boosters flown on the space shuttle and will provide the boosters for the first flights of SLS.

During the test, the case failed within 1 percent of pretest estimates, validating the models for strength of the composites. One-hundred-twelve channels of instrumentation provided data on the case failure. The rocket motor case test is part of an effort to optimize a composite case design that may be stronger, lighter, yet more affordable than traditional steel cases. In turn, this would provide increased payload performance due to reduced weight inherent in composite materials.

After the initial flights of SLS, the rocket will be upgraded from a configuration capable of delivering 70 metric tons (77 tons) to low-Earth orbit to an evolved configuration that will launch 130 metric tons (143 tons). To reach its full capability, SLS will use more powerful boosters. NASA is preparing today for that evolution by working with industry partners to test technologies that could be used to develop new liquid or solid rocket boosters.

For more information on SLS, visit here.

Hitt, an ASRC Federal/Analytical Services employee, supports the Office of Strategic Analysis & Communications.

Student-built GLACIER Arrives to Help Train Marshall Center's Space Station Team

By Bill Hubscher

The flight controllers at the Marshall Space Flight Center's International Space Station Payload Operations Integration Center are borrowing a small refrigerator/freezer from the Johnson Space Center.

Normally, an appliance exchange would not be news, but this is a special kind of mini-fridge, and it will not be used for leftovers or soda.

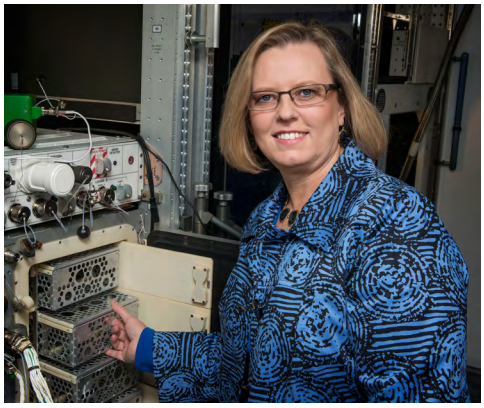
The General Laboratory Active Cryogenic ISS Experiment Refrigerator is a small, ultra-cold freezer that can store samples at temperatures between 4 and minus 160 degrees Celsius. Created at the University of Alabama at Birmingham, GLACIER keeps a variety of biological or chemical samples cryogenically frozen on the International Space Station. When the samples are returned to Earth, scientists analyze them to obtain the bulk of the data for numerous experiments.

Marshall's Laboratory Training Complex in Building 4663 recently installed a non-freezing mock-up of GLACIER on loan from the Johnson Center for the next six months. The LTC is a full-scale model of the station's Destiny module, used by flight controllers in the Payload Operations Integration Center to better understand the real-life constraints of living and working in space.

GLACIER is installed into a rack in the LTC in the same location where it resides on the orbiting laboratory. Johnson uses GLACIER for training astronauts, and now Marshall will use it to train the personnel who coordinate and assist those astronauts with around-the-clock scientific investigations.

"It's a valuable piece of equipment roughly the size of a cooler one would use while tailgating at a football game," said Lisa Smith, the training team lead in Marshall's Mission Operations Laboratory. "GLACIER is part of the family of freezers we have on orbit to lock the scientific samples in growth or development so we can bring them home for further study."

The full-scale model of GLACIER was created as part of the HUNCH program -- High school students United with NASA to Create Hardware -- designed to involve students in building cost-effective hardware to help train astronauts and ground support flight controllers. As part of HUNCH, students at Clear Creek High School in League City, Texas, built the training version of GLACIER using 3-D printed items and machine fabricated metal.



Lisa Smith, the training team lead in Marshall's Mission Operations Lab, examines the drawers in the GLACIER mock-up in the Marshall Center's Laboratory Training Complex. (NASA/MSFC/Fred Deaton)

"Clear Creek High was one of the three original HUNCH charter schools back in 2003," said Bob Zeek, HUNCH project manager at Marshall. "We're glad they are continuing the tradition of helping NASA train our flight controllers. In return, they work with NASA personnel to learn those science, technology, engineering and math skills -- the STEM fields -- that will help them in the future."

While it won't have practical uses as a fridge in the LTC, Zeek says students will soon build in some electronics capabilities, adding active switches, lights and readouts to evolve the unit from merely a physical mock-up to an actual training simulator -- another valuable tool in the training arsenal.

"Without the HUNCH program, we would not have what we have today in the LTC," said Donna Simpson, LTC facility manager. "Much of the hardware in the two modules we use were developed, created and constructed by high school students through HUNCH. It is a solution for both inspiring the next generation of scientists while providing cost-effective hardware for NASA."

Hubscher, an ASRC Federal/Analytical Services employee, supports the Office of Strategic Analysis & Communications.